Published in final edited form as:

Annu Rev Sociol. 2012 August ; 38: . doi:10.1146/annurev-soc-071811-145531.

Making a Place for Space: Spatial Thinking in Social Science

John R. Logan

Abstract

New technologies and multilevel data sets that include geographic identifiers have heightened sociologists' interest in spatial analysis. I review several of the key concepts, measures, and methods that are brought into play in this work, and offer examples of their application in a variety of substantive fields. I argue that the most effective use of the new tools requires greater emphasis on spatial thinking. A device as simple as an illustrative map requires some understanding of how people respond to visual cues; models as complex as HLM with spatial lags require thoughtful measurement decisions and raise questions about what a spatial effect represents.

Keywords

Mapping; Distance; Exposure; Segregation; Spatial dependence; Spatial clustering

INTRODUCTION

There has been a steady growth of interest in a range of concepts and techniques in sociology that can be described as spatial. Much of this builds on a large body of work by geographers, and this review will offer some links to that literature. What is distinctive to sociology (and other social sciences) is the application of spatial data, measures, and models to a wider range of substantive questions with roots in other intellectual traditions. Sociologists are less interested in spatial patterns in themselves, and more interested in how they translate into social relations.

Writing from the perspective of an urban sociologist, I am particularly attuned to the relevance of *place* to social life. Everything happens somewhere, which means that all action is embedded in place and may be affected by its placement. Abbott (1997, pp. 1152) tells us that this is a specifically Chicago School insight, "that one cannot understand social life without understanding the arrangements of particular social actors in particular social times and places... Social facts are *located*." I believe this insight is not unique to the Chicago School. Much of my own research in the last three decades is centered on questions of inequalities between places (Logan 1978). In the urban political economy tradition every place is socially constructed with a history and a future; where people are placed affects their fortunes and adds structure to their lives; place-based interests are at the heart of much collective and political action (Logan and Molotch 1987). Nevertheless for the purpose of this essay, the key concept is not place but space. And by space, I mean specifically location. Spatial thinking is about where things are or where they happen, and it is especially about *where they are in relation to others*. There is an implicit spatial reference in almost all studies of places. What is distinctive about social science in the last decade is that space is being introduced more explicitly and more systematically.

My purpose in this review essay is to examine how key spatial tools and concepts are being used in sociology. I suggest ways in which greater thoughtfulness in their use can yield better results on the initial questions that motivate researchers to use spatial methods and can also lead into more general issues about spatiality.

In a review essay on spatial demography, Voss (2007) argues that traditional demography through the mid-20th Century was “spatial” in the sense that it was the study of ecological units like cities and counties. A shift of focus to individuals and individual-level processes (associated with increased availability of data at this level) pulled demography away from its spatial origins until the advent of multi-level modeling gave us methods to distinguish between processes at the individual and aggregate levels. This use of a spatial vocabulary seems to suggest that counties are spatial but people are not. In a more careful formulation Entwisle (2007) treats both people and places as spatial, but calls for an approach that gives more agency to people – emphasizing that people make choices about where to live, that they move and that their movements can collectively result in changes in place characteristics and restructure their social networks. She suggests that the popularity of multi-level models reinforces a “top-down” understanding of the relation between people and places, because they focus attention on dependent variables at the individual level.

Yet (like Voss) Entwisle’s point of reference is place and the literature on place effects, and she uses the term “spatial” mainly to refer to places as local “social and spatial” contexts. Again, I consider place to be a fundamental concept for spatial social science. Counties, villages and other areal units have *place attributes* that we certainly want to know about. If “where” is a certain residential district, we want to know whether that district is a blue-stocking neighborhood or a ghetto. But for the purpose of this review I call attention to the other attributes that we want to know from a more *explicitly spatial* perspective (e.g., where it is in relation to other places, is it near the center city or out in the suburbs, is it close to a transit line, how long does it take to get to the daycare center, what else is in the vicinity). Concepts that are critical to spatial thinking – distance, proximity, exposure, and access – are all rooted in relative locations. Questions of location are equally spatial regardless of whether the unit of analysis is a person, a firm, or a city, and studies of place that do not deal with location are less so.

One more observation will help to define what I mean by “location.” By now the widespread use of satellite-based geographic positioning systems (GPS) has made us very aware of location as a set of geographic coordinates. And indeed coordinate systems have always been crucial to systematic mapping. GIS maps that make it possible to visualize spatial patterns and to make the measurements required for spatial analysis absolutely rely on measuring longitude and latitude.

Sometimes “location” refers to these points or to locations that can be represented by them – the location of a school or worksite, a crime incident, a riot, a case of measles. Perhaps more often it refers to a larger territory. We use terms like neighborhood or zone to identify a location that is not a single point or address on a map. Such terms seem natural, they are convenient, and they are necessary to spatial thinking. But they introduce two ambiguities. First, what is the geographic scale of the territory? Political studies often deal with world regions or nation states. River basins and valleys define territories for environmental research. Metropolitan labor markets, cities, and more local areas within cities are important to urban analysis. Second, are these territories bounded? Routinely social scientists deal with unmarked boundaries. It can be unclear whether the notion of a boundary is a social construction in the mind of the scientist or a concept grounded in local usage. Does it make more sense to think of boundaries as sharp edges or extended zones of transition? Administrative units that social scientists use regularly in their research, like census tracts,

have established boundaries but their arbitrary character has led some geographers to replace them with continuous surfaces that they believe may better represent the underlying spatial distribution of population characteristics. Even when formal political boundaries have been established, so that there is a clear line of demarcation between one territory and another, one can question their impact or permeability.

When our object of study cannot be located as a point but must instead be thought of as a place, spatial analysis requires that we confront questions about what constitutes the place. Here I treat the distinction between space and place with a different emphasis than did Gieryn (2000, p. 465), who dismissed space as “what place becomes when the unique gathering of things, meanings and values are sucked out.” “In particular,” he said, “place should not be confused with the use of geographic or cartographic metaphors (boundaries, territories) that define conceptual and analytical spaces.” In fact places are not only geographically located and material, as Gieryn points out, but they are also spatial and their spatiality gives rise to fruitful questions.

These remarks lead to a demarcation of the scholarship that I will review here. Spatial thinking is the consideration of the relative locations of social phenomena, the causes of the locational pattern, and its consequences. It encompasses phenomena whose locations can be thought of as discrete points as well as larger territories, and in the latter case, it requires that we consider questions that are posed as strictly geographical, like whether and where territories are bounded. In fact, like most questions of method and measurement, the underlying issues are not technical but substantive. This is why as often as possible I use the term spatial thinking rather than spatial analysis. Although some leading geographers (Goodchild 2004) have sought to build from Geographical Information Systems toward GIScience as a distinct discipline, most scholars’ interest in space is how to incorporate it usefully into their own research agenda. We can profit as much from seeing how others are thinking about space as we can from the advanced tools that are being made available from GIS and spatial statistics.

MAPPING

The most powerful spatial tool is the simplest – creation of a map that allows visualization of a spatial pattern. There has been an explosion of social science mapping in the last decade, advanced especially by the availability of user-friendly software to make original maps and of systems to display maps with web browsers. Maps, like photographs, can provide many layers of information, much of it implicit. I believe their power comes from the combination of their ability to offer an objective representation and their capacity to call on people’s imagination. All aspects of semiotics that are typically applied to other aspects of language and communication are relevant to maps (MacEachen 2004), including how people process visual stimuli, how perception and attention are organized, and the mental categories through which people interpret what they see.

When used in an exploratory way by an analyst who is looking for possible spatial patterns, the map’s utility is dependent on the analyst’s insightfulness. The analyst creates meaning by making associations between the patterns explicitly shown on the map and other extraneous information. Both expected and unexpected observations lead toward new questions. Simple inspection of maps can be facilitated by the use of techniques developed for Exploratory Spatial Data Analysis (ESDA) that draws attention is given to spatial clusters and outliers, and offers methods to “smooth out” random spatial variation so that non-random patterns will stand out more clearly (Anselin, Kim and Syabri 2004). In the sociological literature one of the most common of these tools is the mapping of values of local Moran’s i , a measure of clusters of high or low values on a single variable. Adoption of

this method was facilitated by the early publication of studies that relied heavily on it (several of which are cited below).

A published map can also have a specific intention, a point that the maker wishes to convey. An effective map, like a well written paragraph, often has a rhetorical character. Geographers have long been aware that there is a discipline to making clear and easily interpreted maps, as well as pitfalls that can lead to “lying with maps” (Monmonier 2005). Yet good maps, like good writing, do not lie. Rather they selectively direct one’s attention and train of thought.

Thematic maps have two functions in communicating research results. One is to reinforce findings on the extent of variation in a place characteristic. Seeing the values of a single variable arrayed on a map provides much information in a succinct form. The second function is to demonstrate that the variation has a spatial pattern, offering cues about where values are higher or lower that the viewer can draw on and that the researcher can reinforce in the text as a first step toward reaching conclusions.

Providing maps for these purposes and without any further systematic spatial analysis is now common and is probably the form in which explicit spatial information is most frequently included in social science writing. An excellent example is a study of where people of different race and ethnicity live and work in the Los Angeles metropolitan region (Ellis, Wright and Park 2004). Its conclusion – that groups are typically more segregated in their neighborhoods than in the location of their work – is mainly supported by analysis of segregation indices that use no information about where the concentrations of non-Hispanic whites or Salvadorans are, but only that they are more concentrated in some census tracts than in others. But like many studies dating back to when sociologists had to draw maps by hand, the conclusion is reinforced and elaborated with GIS maps.

These maps show specifically where group members are over-represented or under-represented. For example, two side-by-side maps (Figure 1) show the distribution of native-born whites by where they live and where they work. It is evident that there is a large core area of L.A. where these people are very greatly under-represented *as residents*, labeled by the authors as East L.A. and South Central. These are place names that convey considerable meaning to people with even a vague knowledge of the region. There is an even larger territory in the periphery of the region where they are over-represented. Here the only label that is clearly in such a zone is Malibu, a beach town that also has a clear reputation in American culture. The map of workplaces presents a strong contrast. Almost the entire region (but not East L.A. and South Central) is shown as neither over- nor under-represented, suggesting that whites work almost everywhere in similar proportions. Based on these maps, most readers would have little difficulty reaching the conclusion that whites are more segregated at home than at work, a finding that the segregation indices confirm.

One point that I want to make here is how much information is contained in maps like these, particularly as one map is compared to another, place labels are used to stimulate particular associations, and readers are invited to make sense of the “raw” data for themselves. Of course, another point is that the maps are not the original raw data, but rather they are representations that the authors have thoughtfully constructed to convey their own conclusions about the patterns.

DISTANCE

Distance – the location of something in relation to something else – is often the key message of a map. It is also the core concept in many sorts of spatial research, so central that it is incorporated in the First Law of Geography, which holds that “everything is related, but near

things are more related than distant things” (Tobler 1970, p. 236). In the following sections I review research that treats distance as an indicator of access to other people or resources or exposure to harm, as a feature of social networks, and as a basis for identifying and interpreting clusters of related things (see Logan, Zhang and Xu [2010] for more details about the methods used in such research).

Distance as Access or Exposure

Many studies construct some version of what geographers call “egocentric” neighborhoods (Chaix 2009) or local environments, often based on measuring every person’s proximity to some place characteristic or to every other person in the system (typically, but not always, based on their place of residence). The notion that every person lives at the center of their neighborhood is reinforced by studies of people’s perceptions (Coulton et al. 2001), but typically researchers rely on documentary sources to simulate an egocentric neighborhood. For example Frank et al (2004) defined a one-kilometer circle around a person’s home to study the effect of the built environment (street networks, land use mix, population density) on travel behavior. It is rare for researchers to have precise locational information (except through confidential databases). Most often, therefore, researchers assign people to a census tract or zip code, and pretend that every resident lives at its centroid. An alternative (known as kriging) is to simulate the actual distribution of people (and categories of people) at every point in space. In the latter case analysts proceed *as if* they had exact locational information for every person (e.g., Lee et al 2008).

Distance naturally arises in transportation studies, which consider how the cost of distance can be managed and how it affects people’s behavior. Baum-Snow (2007) asked whether changes in transportation infrastructure – new highways leading from the city center to the suburbs – affected where people live in metropolitan areas. He found that in both 1950 and 1990 there was a strong negative association between population density in census tracts and their distance from an interstate highway, controlling for distance from the central business district. More telling, population growth of central cities during the period (using constant city boundaries) was significantly lower in metropolitan areas with more or increasing numbers of highways radiating out of the city center. Baum-Snow and Kahn (2000) conducted a similar analysis of mass transit access and use. They showed that neighborhoods closer to new transit access points (looking only within a 2 kilometer radius) experienced a significant shift toward commuting via mass transit. But in the metropolitan areas that they studied, expansion of transit lines during the 1980s occurred mainly in the suburbs and improvements were experienced especially in census tracts with more homeowners and college-educated residents, fewer African Americans, and fewer young adults. This finding points toward a concern with spatial inequality (unequal access or exposure by different population groups) that is often the motivation for spatial analysis (Lobao, Hicks and Tickamyer 2008).

A number of social scientists have looked at proximity to employment concentrations in terms of spatial inequality. A familiar concept in the deindustrialization literature is spatial mismatch between people and employment (e.g., Kain 1992). The core idea is that increasingly the metropolitan job base, especially for lower skilled jobs, has shifted to the suburbs, while population groups in need of such jobs (especially young minorities with lower education) are disproportionately found in central cities. Distance from jobs becomes an impediment to being employed. An early effort to test this notion (Cohn and Fossett 1996) evaluated the spatial location of employment in Boston and Houston, particularly in entry-level blue collar positions. The analysis required construction of a measure of employment opportunities that is specific to people living in a given census tract. In both cities, in fact, they found that jobs were highly centralized, as was the black population. They then asked whether the proximity of census tracts to employment opportunities was

related to their racial composition, and reported that in fact blacks were more highly represented in tracts with greater proximity to jobs.

Allard and Danziger (2003) asked whether welfare recipients who live in closer proximity to employment opportunities are more likely to find a job and less likely to remain on welfare than those who live in more job-poor locations. They found that white welfare recipients lived in neighborhoods with better access to jobs than did black recipients, largely due to their more suburban residential pattern. Regardless of race, those with better job access were more likely to get a job and to exit welfare.

Another example of interpreting proximity in terms of access (where being closer is regarded as a positive attribute) is a study of the location of banking outlets in Milwaukee. Squires and O'Connor (1998) documented the avoidance of poor and minority neighborhoods by regular bank branches and their replacement by check-cashing firms and other fringe banking outlets, which they interpreted as inferior service. But proximity can also be treated as exposure to potential harm. This is illustrated in studies of environmental justice, many of which ask whether minorities – by virtue of their location – are disproportionately exposed to pollution. Downey (2006) constructed a measure of exposure to manufacturing facilities in highly polluting industries in Detroit, taking advantage of precise locational information on these facilities. He divided the metropolis into small grid cells and counted how many potentially toxic facilities were located with $\frac{1}{4}$ mile distance of the centroid of the cell, adding these together for all cells in a census tract. He then used tract population data to estimate the differential environmental exposure of whites, blacks, and Latinos. In a more recent study Crowder and Downey (2010) summed the volume of pollutants emitted within 1.5 miles of similar small grid cells. Using longitudinal data from the Panel Study of Income Dynamics (PSID), they were able to show that blacks and Latinos had greater exposure to pollution at the census tract level than whites or Asians, even after controlling for individuals' socioeconomic characteristics. An innovative step was to ask how residential mobility affects this pattern. They found that pollution was not a significant predictor of moving away from a tract for members of any group, but that black householders (and to a lesser extent Latino households) were more likely than whites to move to destinations with higher pollution. Choice of migration destination, then, reinforced racial disparities in environmental exposure.

Residential segregation can also be conceptualized as a spatial exposure, in this case exposure to other people. Michael White (1983) was among the first sociologists to suggest thinking of segregation in terms of the distances between every two persons in a city. In cities where whites tend to live closer to one another than they do to blacks, and blacks tend to live closer to other blacks than to whites, segregation is higher. Working with aggregated data for areas such as census tracts, these distances cannot be precisely measured, but they can be estimated, and White proposed an index that could summarize the spatial pattern of an entire city in terms of groups' relative proximity to one another. Considerable effort has been devoted recently to ways of applying this approach to the construction of "spatial" segregation measures that are analogous to aspatial measures such as the Index of Dissimilarity, exposure and isolation indices, and the information theory index H (Reardon and O'Sullivan 2004). These measures consider people to have some proximity not only to others in the same block or tract, but also to those who live in nearby areas.

Measuring Distance

Key to all studies of access, exposure, or segregation is the question of how to measure distance. Cohn and Fossett's (1996) study of access to jobs tackled this issue directly. They believed that proximity to jobs involved not just Euclidean distance but also how long it actually takes to get from point a to point b. This in turn depended on the mode of

transportation (walking, public transit, auto), which is conditioned by the availability of public transit and automobile ownership. And because whites and blacks in the cities they studied, and in specific neighborhoods in those cities, may have very different transportation options, they recognized that creating a valid measure of “how far a neighborhood is to jobs” is not nearly as simple as measuring distances. Their solution was to develop estimates based on several different scenarios about how transportation access varies across races.

Setting aside the problem of the metric for distance (Euclidean distance, distance along a road network, travel time, travel cost) the usual assumption is that there is some limit beyond which more distant locations are irrelevant (often referred to as a “band width”) and also some distance-decay function $f(d_{ij})$ that evaluates how much more the nearer points matter in comparison to less near points within that range. But how much more should nearby locations be counted, and at what point is the distance too great to matter? Researchers have approached these questions in various ways.

The most satisfying approach is to find a substantive basis for a given choice. Allard and Danziger (2003) used information on commuting patterns in the Detroit region – how long people typically travel between home and work – to help calibrate their decay parameter (that is, how much less weight they give to employment in more distant tracts). However in many cases there is no relevant data. An alternative is to present results using several alternative assumptions. White (1983) offered four different calculations based on a linear decline, two different exponential rates of decline, and decline with the square of distance, and these resulted in slightly different rank-ordering of cities by level of segregation. Downey (2006) similarly evaluated various functions for exposure to pollutants, including two alternative distance-decay curves (curvilinear and inverse curve) at three cutoff distances (.5, 1.5, and 2.5 miles). Like White, he found different results using different functions, which emphasizes that these choices can be consequential.

One could imagine methods of deciding which of these results is the “real” finding. In segregation research, for example, suppose one’s underlying interest were to use geographic data to infer interpersonal contacts within or across racial/ethnic boundaries. In that case one might interview residents to discover at what geographic range they actually notice or talk to other people in their vicinity. This is how Grannis (2009) determined that a single street segment is the key building block of neighborhoods. In environmental studies, suppose that the underlying motive is to estimate health risks from air pollution. Then possibly studies of health outcomes at varying distances from major polluting sources could provide a basis for a decay parameter. Unfortunately we have little knowledge at this level of specificity. Scholars anticipate generally that proximity to pollution is risky, but there is little basis for arguing that one distance function is superior to another.

An interesting alternative in segregation research is to measure exposure not as a single summary statistic but rather as a curve where values of some exposure (e.g., the percentage of Latinos within a given distance of the average Latino resident) are shown to vary with distance. Typically one would expect that people live in relatively more homogeneous social environments at short distances (such as next door neighbors or people on the same block face) but that exposure to co-ethnics (“isolation”) declines at greater distances. This is a widely used technique in geography, and it has been proposed as a method to describe the spatial pattern of segregation. Reardon et al (2008) calculate “spatial” segregation at various cutoff distances, and refer to the resulting curve as a segregation profile. Regions (cities or metropolitan areas) may vary from one another not only in how high the level of isolation is at short distances (such as the spatial scale that could correspond to a typical block or census tract), but also how quickly it declines with distance. The segregation profile offers much more information on the spatial pattern of segregation than a single summary measure.

An objection could be that it provides too much information, since the full segregation profile is not easily summarized and compared across cities or regions. Perhaps for this reason Lee et al (2008) emphasize two alternative scales that they argue have distinctive meanings. Estimating a segregation measure based on a distance-decay function that reaches no further than a 500 meter radius, they propose, corresponds to the case of a pedestrian neighborhood in which walking the dog or taking children to a playground can be done on foot. A radius of 4000 meters, in contrast, is larger than many suburban municipalities, and they treat this as the limit of what residents might consider a neighborhood. Whether these are appropriate scales is an important research question. Possibly the “right” scale will vary across metropolitan regions, depending on the density or development in the region and usual methods of transportation.

A fundamental concern with most research that uses distance measures to assess exposure or access is that we take for granted that the relevant measure is distance from one’s place of residence. This assumption is convenient, because standard data sources identify place of residence. However some research makes the case for alternative conceptions. For example, Pastor, Sadd, and Morello-Frosch (2002) argue that for children’s exposure to environmental pollution, it is at least equally relevant to do measurements in relation to their school. More broadly, Kwan (1999) raises the possibility of an entirely different formulation based on where people actually go on a regular basis – home, work, shopping, and other activities. Using time diaries for Columbus, OH, Kwan seeks to identify the area of the city that is within the “potential path accessibility” of people given the constraints of where they live, where they work, what other routine activities they must perform, and when activities must be performed. In this particular study she demonstrates that women – because their domestic and childcare activities place more constraints on their use of time – have much smaller fields of activity than do men.

DISTANCE AND SOCIAL NETWORKS

Proximity also plays a role in social networks, and increasingly analysts of social networks are considering how the spatial arrangement of actors influences the relationships among them. In a variation of Tobler’s Law, McPherson, Smith-Lovin and Cook (2001, p. 430) observe that “the most basic source of homophily is space: We are more likely to have contact with those who are closer to us in geographic location than those who are distant.”

There are alternative views, such as Wellman’s (1994) notion of the “liberated” community in which people have flexibility in finding shared interests with others. Ties, he argues, are not established primarily in their residential neighborhood but increasingly through secondary associations not connected with either home or work, and more recently through electronic media (Wellman 2001). Fischer (1995) also observes a high degree of personal choice in social networks formed in urban areas, leading to the emergence of urban subcultures, but he notes that subcultures are sometimes reinforced by spatial clustering. Even ties created through the internet may have a spatial pattern (Hampton and Wellman 2000).

Proximity is certainly not the only factor at work. Britton’s (2011) research on neighborhoods in Houston shows that non-Hispanic whites who lived in more integrated neighborhoods actually had *fewer* black friends, except in the case that their black neighbors had high socioeconomic status. But blacks in more integrated neighborhoods had *more* white friends even controlling for their own social class and that of white neighbors. Studies of support networks report that people’s closest exchange relationships are not with neighbors but with family members. On the other hand, family members (especially parents or adult children) who live nearby exchange more support and have more frequent contact

with one another – the combination of kinship and proximity is especially potent (Logan and Spitze 1994).

Spatial proximity is so closely interlinked with network connections that spatial effects are sometimes interpreted in terms of social interaction. Entwistle et al (1996) found large differences across Thai villages and high homogeneity within villages in choice of contraceptive methods, higher than could be accounted for in a multilevel model that included individual and place characteristics. They reasoned that “village boundaries largely coincide with the boundaries of social networks” (1996, p. 9) – networks within which women routinely exchanged information about intimate topics. This conclusion was consistent with focus group interviews that probed women’s interaction patterns. Liu, King and Bearman (2010) noticed that children living very close to a child previously diagnosed with autism were more likely to be given the same diagnosis. They considered several mechanisms that could produce this spatial effect. There could be shared risk from an environmental toxin or contamination of a virus that increases the likelihood of autism. There could be neighborhood selection based on some other personal or family characteristic that induces clustering of risk factors for autism, such as socioeconomic status or parental age. Or there could be a social influence effect resulting from exchange of information between families about symptoms and possible responses to autism. Several findings strengthen the social influence interpretation. In particular, when proximate children lived in different school districts (which would tend to limit parental interaction) the effect of distance to a diagnosed child disappeared. The researchers also took advantage of information about residential mobility. For example, the effect of proximity disappeared if the diagnosed child’s family moved away.

Some researchers have sought to assess the relative strength of spatial proximity and social networks when independent measures are available for each concept. Whittington, Owen-Smith, and Powell (2009) point out that “social structural spaces” and “geographic agglomeration” are not independent. For example studies of industrial districts suggest that one of their advantages is that proximity fosters social connections among employees of otherwise unrelated firms. In their study of biotechnology firms, Whittington, Owen-Smith, and Powell show that innovation (the number of patents issued) is related to measures of physical proximity (the average distance of the firm to all other firms), centrality in relationships with other firms (based on reported formal contractual agreements), and location in one of the three key regions for this industry (San Francisco Bay Area, Boston, and San Diego). Radil, Flint and Tita’s (2010) research on gang-related violence, which explicitly seeks to “spatialize social networks,” concludes that both social network connections (rivalries with other gangs) and proximity (treating adjacent territories as their turf) influence violence. However among many similar studies of health risks, Giebultowicz et al (2011, p. 1387) find that cholera in rural Bangladesh “always clusters in space and seldom within social networks” (as defined by kinship networks).

Wineman, Kabo and Davis (2009) looked at similar questions at the micro-level, examining collaborative innovation by faculty in a professional school, where successful innovation was measured by the number of co-authored articles by each pair of faculty. Being in the same academic department (the indicator of common social network position) had the stronger effect on coauthorship. But proximity (a complex measure of walking distance and line of sight connection between offices) also had a significant impact.

SPATIAL CLUSTERING

Another way that distance is incorporated into social research is through the phenomenon of spatial clustering, the pattern of related things being found in proximity to one another that

Tobler called attention to. When we refer to clusters, we are typically calling attention to zones in which there is a larger than expected concentration of some characteristic. Clustering is the main focus of Weeks' (2004) review of how spatial analysis can be used in demographic studies. An early study of the spatiality of crime (Sherman, Gartin, and Buerger 1989) called attention to the existence of crime "hot spots," pointing out that many types of crime are both rare and spatially concentrated at certain locations (based on statistical measures such as Moran's i). Criminologists have been a major contributor to methods of identifying clusters of point-level phenomena, facilitated in part by specialized software for this purpose such as Crimestat (Levine 2010). Health researchers, who often have access to point data on health conditions, have also shown much interest in spatial clusters. One study of dengue infection in a city in central Brazil (Siqueira et al. 2004) used survey data on dengue infection status, medical condition history, and socioeconomic and demographic characteristics, and evaluated whether there were zones of the city with significantly high concentrations of infection, which could then be targeted for public health interventions. Similar techniques were used to identify clusters of childhood leukemia in west-central Lancashire in England during 1954–1992, based on analysis of the proportion of leukemia cases at various distances from each child (Gatrell et al. 1996).

Distance is the starting point for identifying clusters, and all of the questions about what distance means and how to measure it apply to questions about clusters. An additional central issue is whether what appears to be a "hot spot" could be the result of a random process, which requires an understanding of the statistical properties of spatial distributions. For example there was considerable controversy in New York State when detailed information was made public on the location of cancer cases. The raw data suggested that there might be concentrations of risk in sections of Long Island, but experts disagreed on whether these were real or random (Jacquez and Greiling 2003).

Neighborhoods

Whether based on point data or areal units like blocks or census tracts, another application of cluster analysis is to identify "natural areas" (neighborhoods or regions) based on the composition of smaller units. In such work we presume that the spatial cluster is neither random nor ephemeral, but rather represents the existence of meaningful places. And we can ask specifically where these places are, what they are like, and – perhaps most difficult – what are their boundaries.

Like any social category (Lamont and Molnar 2002) we expect neighborhoods to have both symbolic and social boundaries, and sometimes to have political boundaries as well. These are meaningful and often contested. In an extreme example of a divided city, Shlay and Rosen (2010) describe the clash of alternative narratives that support or reject Israel's effort to shift the Green Line between Jewish and Palestinian zones of Jerusalem. In more typical cases, Suttles (1972, p. 4) argues that residents tend to construct simplified images of the city in which differences between neighborhoods, and hence their boundaries, are magnified. Nonetheless researchers have noticed that it is common for borders to be fluid. Hunter (1974), for example, reported that areas of Chicago that he studied had "rolling" boundaries – people might agree on the name of their neighborhood, but those living near its edge tended to perceive it as extending further in that direction. Recent ethnographic studies of cognitive maps show that residents draw on many of the same characteristics to identify the boundaries of their neighborhoods as do social scientists. Lacy (2007) describes this as "boundary work," and focuses on how residents of middle class black areas seek to signify that their neighborhood is distinct from neighborhoods of black working class or poor people. In a Baltimore neighborhood Rich (2009) found that white residents used both the racial composition and class background of specific blocks to mark the limits of their own neighborhood, emphasizing that the more middle-class and white areas were the heart of

their neighborhood. But in another locale Campbell et al (2009) reported that white residents preferred to draw wider boundaries in order to think of their neighborhood as more racially and occupationally diverse.

A simple thematic map of a population characteristic provides a first approximation of where people of different kinds are geographically concentrated. Some of my own research has sought to be more concrete. Alba, Logan and Crowder (1997, p. 892) operationalized an ethnic neighborhood as “a set of contiguous tracts, which must contain at least one tract where a group is represented as 40% or more of the residents and whose other tracts each have a level of ethnic concentration among residents of at least 35%.” But when we wished to study ethnic neighborhoods of newer immigrant groups in New York and Los Angeles, such as Chinese or Filipinos, only a handful of census tracts met this criterion, and much of Los Angeles would be defined as a Mexican neighborhood by such criteria. Thematic maps showed visible concentrations of several immigrant minority groups that typically extended across many tracts (Logan, Alba and Zhang 2002). This led us to propose the use of local spatial clustering at the tract level (the same local Moran’s i as used in studies mentioned above to identify spatial clusters of crime or disease) to identify statistically significant clusters, and we treated these larger areas as the groups’ ethnic neighborhoods (see also Logan and Zhang 2004). Grannis (2009) reaches a somewhat similar result by a different route, proposing to identify what he calls t -neighborhoods within areas bounded by major streets and validating this designation with evidence of social homogeneity within these areas.

Establishing Boundaries

More recently I have experimented with other spatial clustering techniques using a data set for Newark, NJ, in 1880 for which we know the location of every household (Logan, Spielman, Xu and Klein 2011). This approach frees us from having to accept arbitrary administrative units as the building blocks of German or Irish neighborhoods, but we are far from being able to know when a given solution is the right one. There are fundamental conceptual issues that need to be resolved, such as whether areas with diverse populations should be seen as transitional zones between neighborhoods (fuzzy boundaries) or as a distinctive neighborhood type in their own right. Additional information such as the location of local ethnic institutions and services or residents’ social networks is needed to understand the nature of boundaries between areas.

Political boundaries have special significance because they can be very real and concrete in their effects, allocating different resources and rights to people on either side of the line. Lichter et al (2007) investigated how the drawing of the line itself may depend on intentions about whom to serve. Their study of annexation in small Southern towns suggests that some areas, based on their racial or class composition, tended to be avoided when town officials extended their borders. Boustan (2007) asked how the border between central cities and suburbs affected housing prices for homes that were otherwise similar (in terms of reported condition, tenure, and density), except that one was on the side of the jurisdiction with a smaller minority population. House prices were higher on this side, regardless of the proportion of minority residents on the block. Boustan estimates that one quarter of this “homogeneity premium” is associated with a preference for children to attend a high school with more white classmates. The latter interpretation is reinforced by research by Saporito and Sohoni (2007) that compared the composition of the school population in particular public schools and in the attendance areas of those schools. They reported that concentrated poverty in local public schools was strongly influenced by decisions of local families to send their children to private schools in the same city, with substantial impact on the schools attended by minority children: “While the typical black or Hispanic child lives in an attendance boundary in which 36 percent of the children are poor, the typical black or

Hispanic public school student attends a school in which 63 percent of the students are poor” (2007, p. 1246).

SPATIAL DEPENDENCE AS AN EFFECT ON NEIGHBORS

Clustering is a form of spatial dependence, the tendency for similar things to be near to one another. In the studies mentioned above, spatial dependence was used to identify significant concentrations or to place boundaries around neighborhoods. Another interpretation emphasizes diffusion across boundaries or impact on neighbors. An early example of this interpretation is a study of county-level homicide rates (Baller et al 2001). It was observed that homicide rates are spatially clustered, particularly high in the American South. The authors argue that this clustering can provide information about the processes that lead to higher or lower homicide. They estimate a multivariate model in which the homicide rate is predicted by several variables believed to be linked to homicide in the criminology literature, such as resource deprivation, and then they analyze the spatial clustering of residuals from this model. Two processes are considered. If the covariance of model residuals with the values of homicide in neighboring counties is high, this is understood as evidence that neighboring areas in fact have an influence even after controlling for the measured predictors. This is termed “spatial lag,” and it is dealt with by introducing the homicide rates of adjacent counties directly into the model as an additional predictor. If the covariance of model residuals in an area with model residuals in neighboring areas is high, this is considered to be evidence that clustering is due to the effects of unmeasured predictors. This is termed “spatial error,” and it is treated with the regression error term.

Baller et al. added another step to the analysis, asking whether the causal processes are the same in the South and non-South parts of the country (which they term “spatial heterogeneity”). This issue is commonly associated with an analytical technique called geographically weighted regression (Fotheringham, Brunsdon and Charlton 2002). Based on several statistical tests they decided to study the South and non-South as separate “homicide regimes.” In the South, they showed that a number of substantive predictors have significant effects but do not account for the residual spatial clustering. They interpreted this evidence of spatial lag in terms of “diffusion,” appealing to a number of prior studies that hypothesized that violence can diffuse across space.

Another study by Baller (Baller and Richardson 2002) reported a spatial lag effect in analyses of the geographic clustering of suicides in French departments in the late 19th Century. They asked whether clustering is due to the fact that the predictors of suicide (such as measures of social integration) are themselves spatially clustered (the position argued by Emil Durkheim at the time) or to the influence of events in one locale on behaviors in adjacent areas (which they describe as the “imitation” hypothesis of Gabriel Tarde). The data seem to support the imitation hypothesis, though the authors emphasize that more direct evidence is needed to show how events in one place actually influence later events in another place – the sort of evidence that is rarely offered in such research. An exceptional case is a study of homicide in Pittsburgh during a period of rapidly increasing youth violence in 1987-95. Cohen and Tita (1999) take advantage of annual reporting of the location of homicides in the city to examine spatial dependence in homicides over time (i.e., whether homicides at time 2 are spatially associated with homicides at time 1 in adjacent areas). They find evidence of “contagious diffusion” only at the peak of the homicide epidemic, “when high local rates of youth-gang homicides are followed by significant increases in neighboring youth-nongang rates” (p 491).

SPATIAL DEPENDENCE IN MULTI-LEVEL MODELS

Multilevel models, which have become much more widely used in the last decade, treat spatial dependence as a statistical problem. The simplest multilevel question focuses on contextual effects, the impact that characteristics of places or other kinds of contexts have on people or other kinds of actors within them. It has become common, for example, for large scale survey datasets such as the PSID to include geographic identifiers so that researchers can use place characteristics as predictors of individual outcomes. The notion is that something about the context, such as its racial composition or poverty level or density, has a direct impact on people within it. Hierarchical linear modeling (HLM) treats the commonality among people in the same locale as a violation of the assumption of independent observations that is required in ordinary least squares (OLS) regression. HLM estimates standard errors for the coefficients of contextual variables in these models that are corrected for the (spatial) dependence across individuals.

Adding Spatial Lags to Multi-Level Models

A more complex situation is when one is interested in contextual effects but also wishes to take into account spatial dependence of individual outcomes across nearby places. Early efforts to conceptualize and deal with this sort of issue are associated with the Project on Human Development in Chicago Neighborhoods (PHDCN). I will focus here on a single seminal publication from that research, where the substantive question is how to explain variations in residents' reports of what the authors call "collective efficacy for children" (Sampson, Morenoff and Earls 1999). For simplicity, I will refer to only one indicator of collective efficacy – informal social control – which refers to the expectation that neighborhood residents will intervene in children's misbehavior.

The core hypothesis takes the same form as contextual effects that can be estimated through HLM. It is proposed that there is variation among individuals in their evaluation of informal social control in their neighborhood, based on such factors as their race, socioeconomic status, and length of residence in the area. In addition, there are aspects of the local social structure that lead some neighborhoods to be perceived as having more social control than others. The authors view these contextual characteristics, including residential instability and concentrated disadvantage, as factors that can reinforce or disrupt effective social networks and collective capacity, over and above the effects of similar factors measured at the individual level. This combination of individual and neighborhood effects is well suited for multilevel modeling.

The next theoretical step is to introduce a more explicitly spatial dynamic. The researchers propose to take into account what they call the "embeddedness" of neighborhoods within the larger urban setting. "If social capital is truly relational, then research that considers neighborhoods as islands unto themselves misses the theoretical point ... [T]he resources in one neighborhood are linked to those in surrounding neighborhoods." Furthermore, "spatial 'flows' for dimensions of social capital are also theoretically compelling because social networks and exchange processes cross the artificial boundaries" of census tracts (1999, p. 637). These influences create positive and negative externalities for adjacent areas. And in fact, this study showed evidence that child social control in a given neighborhood is as much related to social control in surrounding neighborhoods as it is affected by such internal neighborhood characteristics as concentrated disadvantage.

A series of analyses from the PHDCN (see also, for example, Morenoff [2003]) demonstrate the promise of studies that consider both individual-level and contextual effects, as well as what Sampson, Morenoff, and Earls referred to as embeddedness. Chaix et al (2005), studying mental disorders in Sweden, suggest more complex methods that depend on being

able to assess what they call spatially adaptive rings at various distances around individuals, showing much stronger effects of nearby areas than could be found using fixed administrative units. Similar datasets are becoming more widely available (such as LAFANS and AdHealth), and we can anticipate that more researchers will become interested in such spatial effects.

Spatial Effects and Spatial Scale

As in the studies of homicide and suicide discussed above, Sampson, Morenoff, and Earls (1999) use spatial effects as evidence that behavioral patterns can be transmitted across space to neighboring areas. There is an alternative interpretation, which illustrates how strongly the interpretation of complex model results depends on theory. The authors are careful to note (1999, p. 645) that “spatial dependence also arises as a result of the often-inexact correspondence between the neighborhood boundaries imposed by the census and the ecological patterning of social interactions.” In other words, possibly census tracts are the wrong scale of analysis or they create artificial boundaries between areas that should better be understood as in the same neighborhood. Scholars familiar with Chicago are aware that there are very large expanses of territory that are occupied by lower income African Americans, or middle class whites, or Latinos. Maps from PHDCN research show that other place characteristics, such as crime rates or informal social control, also extend over large areas, and that these overlap to a large extent with the mapping of race/ethnicity and class. Suppose we thought of spatial dependence as a tool for identifying neighborhood areas, as in Logan, Alba, and Zhang (2002)? Then we might expect that Chicago’s 865 census tracts could be combined not as 343 “neighborhood clusters” (as in the PHDCN, between 2 and 3 tracts per neighborhood), but more realistically might constitute neighborhoods that are closer in scale to the 77 “community areas” of traditional Chicago ecology (more than 10 tracts per neighborhood). And “spatial lags” in an analysis done at this scale might not be significant. Do spatial lag coefficients mean that behaviors cross into adjacent neighborhoods, or do they indicate that the neighborhood was too narrowly defined? How do we evaluate the appropriate scale for such research?

Studies conducted within metropolitan regions must take a position on the scale of neighborhoods. For example, should neighborhoods be built up from tracts or smaller units within tracts? Hipp (2007) addressed this question by asking at what scale neighborhood characteristics affect residents’ experience of crime. He showed that racial/ethnic composition is a more significant predictor at the scale of the census tract than the block, but the effects of average income are greater at the finer scale of the local block.

The usual emphasis on intra-metropolitan differentiation partly reflects the character of the exposures that researchers believe are linked to distance, most of which are not considered to be of importance beyond a certain point (typically not beyond a daily commuting radius). Lobao, Hicks and Tickamyer (2008) criticize this focus with respect to studies of the spatiality of poverty. In their view, there are traditions of scholarship in sociology that particularly privilege two spatial scales. One of these is the local level addressed especially by urban sociology. The other is cross-national and comparative sociology, which especially addresses inequalities between nations. In either tradition the scale tends to be taken for granted, as though it were imposed by the substantive topic being studied. Lobao et al argue for the importance of the “missing middle” subnational scale (operationalized as differences between regions, states or counties), as does Snyder (2001). A more general point is that sociologists should treat spatial scale as a research question and consider the linkages of processes across scales. We are becoming more aware of how processes of globalization organized at a supra-national scale may be reducing the relative importance of national boundaries and accentuating regional agglomerations and networks of cities (Brenner 2004). The same degree of sensitivity is needed at every spatial scale.

LOOKING FORWARD

Spatial analysis is on a roll. The growing availability of spatially referenced data and the inclusion of geographic identifiers in large scale survey data sets both respond to and reinforce a demand for studies that take place and space more explicitly into account. The basic computing tools are much more easily accessible today than they were in the past, when only specialists could manipulate the programs that make computer maps. Now even general purpose statistical programs include corrections for spatial autocorrelation or clustered sampling, measures of spatial dependence, and procedures for multilevel modeling and spatial regression. The research reviewed is a very partial introduction to the range of spatial questions that are being asked in many areas of social science.

My intention is to promote more sensitivity in use of spatial concepts. Not long ago it was considered to be sophisticated to recognize the ecological fallacy, the point that one cannot infer processes that occur at the level of individuals from information about relationships at the level of places or other social contexts. The distinction between individual and contextual effects is now much better understood. But the difference between place and space with which I introduced this essay may seem obscure, the concept of spatial lag effects in multivariate analysis is new to most social scientists, and it is hard to question how to measure distance when it is only recently that any measure of proximity was in reach. I fully understand Gieryn's impatience with "geographic or cartographic metaphors (boundaries, territories) that define conceptual and analytical spaces" since these may seem to be very formal categories of thought. I hope to have shown that behind these metaphors are significant theoretical and substantive concerns that should guide our use of the new spatial tools at our disposal.

Literature cited

- Abbott A. Of time and space: the contemporary relevance of the Chicago School. *Social Forces*. 1997; 75:1149–1182.
- Alba RD, Logan JR, Crowder K. White neighborhoods and assimilation: the greater New York region, 1980–1990. *Social Forces*. 1997; 75:883–909.
- Allard SW, Danziger S. Proximity and opportunity: how residence and race affect the employment of welfare recipients. *Housing Policy Debate*. 2003; 13:675–700.
- Anselin L, Kim YW, Syabri I. Web-based analytical tools for the exploration of spatial data. *Journal of Geographical Systems*. 2004; 6:197–218.
- Baller RD, Richardson KK. Social integration, imitation, and the geographic patterning of suicide. *American Sociological Review*. 2002; 67:873–888.
- Baller RD, Anselin L, Messner SF, Deane G, Hawkins DF. Structural covariates of U.S. county homicide rates: incorporating spatial effects. *Criminology*. 2001; 39:561–590.
- Baum-Snow N. Did highways cause suburbanization? *Quarterly Journal of Economics*. 2007; 122:775–805.
- Baum-Snow N, Kahn M. The effects of new public projects to expand urban rail transit. *Journal of Public Economics*. 2000; 77:241–263.
- Boustan, LP. Escape from the city? the role of race, income, and local public goods in post-war suburbanization. 2007. NBER Working Paper No. 13311
- Brenner, N. *New state spaces: urban governance and the rescaling of statehood*. Oxford University Press; Oxford and New York: 2004.
- Britton ML. Close together but worlds apart? residential integration and interethnic friendship in Houston. *City and Community*. 2011; 10:182–204.
- Campbell E, Henly JR, Elliott DS, Irwin K. Subjective constructions of neighborhood boundaries: lessons from a qualitative study of four neighborhoods. *Journal of Urban Affairs*. 2009; 31:461–490.

- Chaix B. Geographic life environments and coronary heart disease: a literature review, theoretical contributions, methodological updates, and a research agenda. *Annual Review of Public Health*. 2009; 30:81–105.
- Chaix B, Merlo J, Subramanian SV, Lynch J, Chauvin P. Comparison of a spatial perspective with the multilevel analytical approach in neighborhood studies: the case of mental, behavioral disorders due to psychoactive substance use in Malmo, Sweden, 2001. *American Journal of Epidemiology*. 2005; 162:171–182. [PubMed: 15972939]
- Cohen J, Tita G. Diffusion in homicide: exploring a general method for detecting spatial diffusion processes. *Journal of Quantitative Criminology*. 1999; 15:451–493.
- Cohn S, Fossett M. What spatial mismatch? The proximity of blacks to employment in Boston and Houston. *Social Forces*. 1996; 75:557–572.
- Coulton CJ, Korbin J, Chan T, Su M. Mapping residents' perceptions of neighborhood boundaries: a methodological note. *American Journal of Community Psychology*. 2001; 29:371–383. [PubMed: 11446289]
- Crowder K, Downey L. Inter-neighborhood migration, race, and environmental hazards: modeling micro-level processes of environmental inequality. *The American Journal of Sociology*. 2010; 115:1110–1149.
- Downey L. Environmental racial inequality in Detroit. *Social Forces*. 2006; 85:771–796.
- Ellis M, Wright R, Park V. Work together, live apart? Geographies of racial and ethnic segregation at home and at work. *Annals of the Association of American Geographers*. 2004; 94:620–637.
- Entwisle B. Putting people into place. *Demography*. 2007; 44:687–703. [PubMed: 18232206]
- Entwisle B, Rindfuss R, Guilkey DK, Chamrathirong A, Curran SR, Sawangdee Y. Community and contraceptive choice in rural Thailand: a case study of Nang Rong. *Demography*. 1996; 33:1–11. [PubMed: 8690134]
- Fischer C. The subcultural theory of urbanism: a twentieth-year assessment. *American Journal of Sociology*. 1995; 101:543–577.
- Fotheringham, AS.; Brunson, C.; Charlton, M. Geographically weighted regression: the analysis of spatially varying relationships. Wiley; Chichester: 2002.
- Frank LD, Engelke P, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine*. 2004; 27:87–96. [PubMed: 15261894]
- Gatrell AC, Bailey TC, Diggle PJ, Rowlingson BS. Spatial point pattern analysis and its application in geographical epidemiology. *Transactions of the Institute of British Geographers*. 1996; 21:256–274.
- Giebultowicz S, Ali M, Yunus M, Emch M. A comparison of social and spatial clustering of cholera in Matlab, Bangladesh. *Health and Place*. 2011; 17:490–497. [PubMed: 21195655]
- Gieryn T. A space for place in sociology. *Annual Review of Sociology*. 2000; 26:463–496.
- Goodchild MF. GIScience, geography, form, and process. *Annals of the American Association of Geographers*. 2004; 94:709–714.
- Grannis R. The importance of trivial streets: residential streets and residential segregation. *American Journal of Sociology*. 1998; 103:1530–1564.
- Grannis, R. From the ground up: how the layered stages of neighbor networks translate geography into neighborhood effects. Princeton University Press; Princeton, NJ: 2009.
- Hampton, KN.; Wellman, B. Examining community in the digital neighborhood: early results from Canada's wired suburb. In: Ishida, T.; Isbister, K., editors. *Digital cities: technologies, experiences and future perspectives*. Springer-Verlag; Heidelberg: 2000. p. 194–208.
- Hipp JR. Block, tract, and levels of aggregation: neighborhood structure and crime and disorder as a case in point. *American Sociological Review*. 2007; 72:659–680.
- Hunter, A. *Symbolic communities*. University of Chicago Press; Chicago: 1974.
- Jacquez GM, Greiling DA. Local clustering in breast, lung and colorectal cancer in Long Island, New York. *International Journal of Health Geography*. 2003; 2:3.
- Kain JR. The spatial mismatch hypothesis: three decades later. *Housing Policy Debate*. 1992; 3:371–460.

- Kwan MP. Gender and individual access to urban opportunities: a study using space-time measures. *Professional Geographer*. 1999; 51:210–227.
- Lacy, KR. *Blue-chip black: race, class, and status in the new black middle class*. University of California Press; Berkeley, CA: 2007.
- Lamont M, Molnar V. The study of boundaries in the social sciences. *Annual Review of Sociology*. 2002; 28:167–197.
- Lee BA, Reardon SF, Firebaugh G, Farrell CR, Matthews SA, O'Sullivan D. Beyond the census tract: patterns and determinants of racial segregation at multiple geographic scales. *American Sociological Review*. 2008; 73:766–791.
- Levine, N. *CrimeStat: a spatial statistics program for the analysis of crime incident locations (v 3.3)*. Ned Levine & Associates, Houston, TX, and the National Institute of Justice; Washington, D.C.: 2010.
- Lichter DT, Parisi D, Grice SM, Taquino M. Municipal underbounding: annexation and racial exclusion in small Southern towns. *Rural Sociology*. 2007; 72:47–68.
- Liu KY, King M, Bearman PS. Social Influence and the Autism Epidemic. *American Journal of Sociology*. 2010; 115:1387–1434.
- Lobao L, Hicks G, Tickamyer A. Poverty and inequality across space: sociological reflections on the missing-middle subnational scale. *Cambridge Journal of Regions, Economy and Society*. 2008; 1:89–113.
- Logan JR. Growth, politics, and the stratification of places. *American Journal of Sociology*. 1978; 84:404–416.
- Logan, JR.; Molotch, HL. *Urban fortunes: the political economy of place*. University of California Press; Berkeley: 1987.
- Logan JR, Alba RD, Zhang W. Immigrant enclaves and ethnic communities in New York and Los Angeles. *American Sociological Review*. 2002; 67:299–322.
- Logan JR, Spitze GD. Family neighbors. *American Journal of Sociology*. 1994; 100:453–476.
- Logan, JR.; Zhang, W. Identifying ethnic neighborhoods with census data. In: Goodchild, MF., editor. *Spatially Integrated Social Science*. Oxford University Press; New York: 2004. p. 113–126.
- Logan JR, Zhang W, Xu H. Applying spatial thinking in social science research. *GeoJournal*. 2010; 75:15–27. [PubMed: 20431703]
- Logan JR, Spielman S, Xu H, Klein PN. Identifying and bounding ethnic neighborhoods. *Urban Geography*. 2011; 32:334–59. [PubMed: 24039327]
- MacEachen, AM. *How maps work: representation, visualization, and design*. Guilford Press; New York: 2004.
- McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: homophily in social networks. *Annual Review of Sociology*. 2001; 27:415–44.
- Monmonier M. Lying with maps. *Statistical Science*. 2005; 20:215–22.
- Morenoff JD. Neighborhood mechanisms and the spatial dynamics of birth weight. *American Journal of Sociology*. 2003; 108:976–1017.
- Pastor M Jr, Sadd JL, Morello-Frosch R. Who's minding the kids? pollution, public schools, and environmental justice in Los Angeles. *Social Science Quarterly*. 2002; 83:262–280.
- Radil SM, Flint C, Tita GE. Spatializing social networks: using social network analysis to investigate geographies of gang rivalry, territoriality, and violence in Los Angeles. *Annals of the Association of American Geographers*. 2010; 100:307–326.
- Reardon SF, Matthews SA, O'Sullivan D, Lee BA, Firebaugh G, Farrell CR, Bischoff K. The geographical scale of metropolitan racial segregation. *Demography*. 2008; 45:489–514. [PubMed: 18939658]
- Reardon SF, O'Sullivan D. Measures of spatial segregation. *Sociological Methodology*. 2004; 34:121–162.
- Rich MA. 'It depends on how you define integrated': neighborhood boundaries and racial integration in a Baltimore neighborhood. *Sociological Forum*. 2009; 24:828–853.
- Sampson R, Morenoff J, Earls F. Beyond social capital: spatial dynamics of collective efficacy for children. *American Sociological Review*. 1999; 64:633–660.

- Saporito S, Sohoni D. Mapping educational inequality: concentrations of poverty among poor and minority students in public schools. *Social Forces*. 2007; 85:1227–1253.
- Sherman LW, Gartin PR, Buerger ME. Hot spots of predatory crime: routine activities and the criminology of place. *Criminology*. 1989; 27:27–56.
- Shlay A, Rosen G. Making place: the shifting green line and the development of Greater Metropolitan Jerusalem. *City and Community*. 2010; 9:358–389.
- Siqueira JB, Martelli CMT, Maciel IJ, Oliveira RM, Ribeiro MG, Amorim FP, et al. Household survey of dengue infection in central Brazil: Spatial point pattern analysis and risk factors assessment. *American Journal of Tropical Medicine and Hygiene*. 2004; 71:646–651. [PubMed: 15569799]
- Snyder R. Scaling down: the subnational comparative method. *Studies in Comparative International Development*. 2001; 36:93–110.
- Squires GD, O'Connor S. Fringe banking in Milwaukee: the rise of check cashing businesses and the emergence of a two-tiered banking system. *Urban Affairs Review*. 1998; 34:126–163.
- Suttles, GD. *The social construction of communities*. University of Chicago Press; Chicago: 1972.
- Tobler WR. A computer movie simulating urban growth in the Detroit Region. *Economic Geography*. 1970; 46:234–240.
- Voss PR. Demography as a spatial social science. *Popul. Re.s Policy Rev*. 2007; 26:457–476.
- Weeks, J. The role of spatial analysis in demographic research. Chapter 19. In: Goodchild, Michael F.; Janelle, Donald G., editors. *Spatially Integrated Social Science*. Oxford University Press; New York: 2004.
- Wellman B. The community question: the intimate networks of East Yorkers. *American Journal of Sociology*. 1994; 84:1201–1231.
- Wellman B. Physical place and cyberplace: the rise of personalized networking. *International Journal of Urban and Regional Research*. 2001; 25:227–252.
- White MJ. The measurement of spatial segregation. *The American Journal of Sociology*. 1983; 88:1008–1018.
- Whittington KB, Owen-Smith J, Powell WW. Networks, propinquity and innovation in technological communities. *Administrative Science Quarterly*. 2009; 54:90–122.
- Wineman JD, Kabo FW, Davis GF. Spatial and social networks in organizational innovation. *Environment and Behavior*. 2009; 41:427–442.

Summary Points

Analyses of place-level data become spatial when they introduce the relative locations of places as a major consideration.

Maps are powerful tools whose effectiveness depends on how well they engage the interpretive imagination of the viewer.

Much spatial analysis – using terms like proximity, connection, exposure, access – involves measuring distance. Distance should not be treated as a fixed metric; it is a complex sociological concept.

Spatial dependence – the phenomenon that similar things tend to be clustered together – has many potential sources and therefore its interpretation depends heavily on theory.

Figure 1.
Distribution of native non-Hispanic whites in Los Angeles, 1990, by place of residence and place of work. Source: Prepared by Richard Wright, Dartmouth University.